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ABSTRACT

The objectives of this study are to assess the current environmental knowledge base in a national probability sample of American high school students, and examine the distribution of environmental knowledge across several variables which have been found to be related to environmental knowledge in previous research (e.g. education and gender). Tenth-grade and 12th-grade environmental knowledge was operationally defined as a student's score on a subscale of seven survey items. The analysis revealed low levels of environmental knowledge. A majority of students were able to recognize basic facts concerning environmental problems; however, most students could not apply their knowledge in order to comprehend the consequences or potential solutions related to the problems. Students also demonstrated extremely little growth in environmental knowledge from 10th-grade to 12th-grade. Parental level of education, quantity of high school science courses, and gender (in favor of males) all were found to be significantly related to the students' levels of environmental knowledge. Educational implications and recommendations are discussed in terms of the results of the study. Includes the survey questionnaire. (Author/LZ)

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A National Survey of Environmental Knowledge in High School Students: Levels of Knowledge and Related Variables

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Abstract

The objectives of this study were to assess the current environmental knowledge base in a national probability sample of American high school students, and examine the distribution of environmental knowledge across several variables which have been found to be related to environmental knowledge in previous research (e.g., education and gender). The analysis revealed low levels of environmental knowledge. A majority of the students were able to recognize basic facts concerning environmental problems; however, most students could not apply their knowledge in order to comprehend the consequences or potential solutions related to the problems. Students also demonstrated extremely little growth in environmental knowledge from tenth-grade to twelfth-grade. Parental level of education, quantity of high school science courses, and gender (in favor of males) all were found to be significantly related to the students' levels of environmental knowledge. Educational implications and recommendations are discussed in terms of the results of the study.

Environmental problems have become a national concern. In a recent poll, 84% of individuals surveyed reported that they believed that pollution in the country as a whole is serious and getting worse, and 71% agreed that we must protect the environment even if it means higher taxes (Berke, 1990). The environmental dilemmas that citizens will face in the future will be even more complex and hazardous than those which already exist. With environmental problems playing a more prominent role in the lives of citizens, it is important to obtain a better understanding of what young people know about the environment and what factors contribute to that knowledge.

The current wave of environmental consciousness is bringing environmental issues into the mainstream of American popular culture and making data about environmental issues more available. Several instances in the realm of politics, finance, news media, and entertainment have demonstrated the public's increasing concern and a reshuffling of priorities in regard to environmental issues. There has been a virtual explosion of information pertaining to environmental issues. With environmental issues receiving greater attention, young adults and other citizens have more accessibility to information regarding the environment than ever before. However, recent research appears to support a conclusion reached by Gigliotti (1990): "We seem to have produced a citizenry that is emotionally charged but woefully lacking in basic ecological knowledge" (p. 9).

environmental issues. Over the last several years a series of popular referenda on nuclear power appeared on the general election ballots of various states (Miller, 1983). If the citizenry is going to effectively confront the growing environmental problems of the nation and make informed decisions about them, then they must be equipped with a fundamental knowledge of the problems that face the environment.

Blum (1987) found that high school students possess low levels of environmental knowledge when he compared five surveys conducted in the United States, Australia, England, and Israel designed to assess environmental knowledge and beliefs of ninth-grade and tenth-grade students. The surveys shared several items which assessed students' knowledge of environmental facts (e.g., sun as a major energy source in future) and concepts (e.g., living creatures are interdependent). Results indicated that sex (in favor of males) and general achievement level were the most influential contributing factors to environmental knowledge, and that the students' beliefs in environmental causes were generally stronger than their factual and conceptual knowledge. In all four countries, less than half of the students understood the use of water in atomic power plants. Blum credited a compulsory junior high school biology class with providing Israeli students with relatively more environmental knowledge than their American and English counterparts; however, he concluded that even across different countries, students' levels of factual and conceptual knowledge were rather low and that schools have much to do to

acidic precipitation" and "Chemical pollutants and water are in the atmosphere." The students in grade eleven only approached a "high partial" understanding (i.e., recognized and understood most of the concept) on four of the twelve concepts. As expected, the younger students displayed even lower levels of comprehension. These results led the authors to conclude: "It is apparent that students understand only a small fraction of what we consider necessary for a full understanding of the acid deposition phenomena" (p. 40).

Recently, Miller (1990) explored the current levels of environmental knowledge of American adults. Miller (1990) conducted a survey with a national probability sample designed to investigate the public's understanding of science and technology in the United States. One component of the study examined the public's knowledge about acid rain and the hole in the ozone layer. Results of the analyses revealed that only about a quarter of Americans have a minimal understanding of acid rain and the hole in the ozone layer. The results also demonstrated the influence of formal education, science and math course taking, and gender on environmental knowledge. A consistent finding across all forms of environmental knowledge was that male citizens who had completed formal education and had taken more classes in science and math were significantly more likely to understand the problems of acid rain and the thinning ozone layer. However, Miller (1990) reported that the difference between males and females was largely accounted for by

relationship" (p. 291).

The purpose of the present study is two-fold. First, the study will assess the current environmental knowledge base in a national probability sample of American high school students. While this assessment will by no means be exhaustive, it will provide a reference point for future investigations. Second, the study will examine the distribution of environmental knowledge across several variables which have been found to be related to environmental knowledge in previous research (e.g., education and gender).

METHOD

Procedure and Sample

The data analyzed were from the Longitudinal Study of American Youth (LSAY), a four-year panel study collecting data from students, teachers, and parents (Miller, Suchner, Hoffer, Brown, & Pifer, 1991). The LSAY was designed to examine the development of science and mathematics attitudes and achievement in middle school and high school students. The LSAY includes a national probability sample of 52 middle schools and 51 high schools. The subjects in the present study consisted of a national probability sample made up of approximately 2,900 high school students who are presently participating in the LSAY.

The first and third year science achievement tests, developed from the 1985-1986 National Assessment of Educational

from ninth-grade through twelfth-grade. A lab science class was defined as a course in biology, chemistry, or physics in which laboratory experiences were a major component of the course curriculum. Courses such as life science, earth science, and physical science were not considered lab classes. If a student reported a lab class in either the fall semester or spring semester, it was assumed that the student had the class for a full year. A listwise method of deleting missing data was used which eliminated students who did not complete a questionnaire for a full year (neither fall nor spring semesters). Students who dropped out of high school in twelfth-grade were assigned the number of science courses they had completed up to the point they dropped out. The scale ranged from 0 classes taken to 6 classes taken representing increasing formal science education. Because so few students took more than four classes (.02%), categories 4 through 6 were collapsed for analyses.

III. Gender. Students' gender was reported by the student on a questionnaire administered in fall 1987 when the students were in tenth-grade.

IV. Environmental Knowledge. Environmental knowledge represents a student's ability to understand and evaluate the impact of society on the ecosystem. This knowledge was demonstrated by recognizing environmental problems as well as comprehending the origins, implications, and consequences of

examined individually as well as collectively as a scale in order to determine the current levels of environmental knowledge in the sample. Second, the distribution of twelfth-grade environmental knowledge was examined across three criterion variables which were found to be related to environmental knowledge in previous research. The following variables were used: the formal education of the student's parent (parental education), the number of science classes a student has taken in high school, and student's gender.

In order to provide a standard from which to compare students, individuals who answered at least five of seven items correctly were classified as having a satisfactory level of environmental knowledge. Students who answered less than five items correctly were classified as having an unsatisfactory level of environmental knowledge. For each criterion variable (parental education, number of science classes taken, and student's gender), a chi-square test of independence was computed to examine the relationship between the criterion variables and the students' level (satisfactory or unsatisfactory) of environmental knowledge.

RESULTS

Levels of Environmental Knowledge

The items that make up the environmental knowledge scales measure a student's ability to understand basic environmental

of the greenhouse effect.

Students' understanding of acid rain was also discouraging. Almost 70% of the students correctly answered that sulfur dioxide released by a factory's smokestack would eventually fall to the earth as acid rain. However, only 39.2% of the tenth-graders recognized the more scientific explanation of the process of acid rain (sulfides of metals cause acid rain), and when given an example of a company manufacturing sulfuric acid as a waste by-product, only 44.8% of the students could identify neutralizing the escaping acid as the best solution to the acid rain problem.

Two years later in twelfth-grade, almost the same proportion of students (61.3%) named the burning of fossil fuels as the primary source of energy in this country. Almost three-quarters (72.2%) of the students understood that environmental groups are concerned about burning coal to produce electricity because it causes pollution. Approximately 45% of the sample were cognizant that the burning of fossil fuels will lead to a warmer climate. This finding suggests that while a majority of twelfth-grade students know that burning fuel causes pollution, less than half understand the environmental consequences of utilizing that energy source. Similarly, only 43.5% of the high school seniors could correctly identify three consequences of the greenhouse effect.

Once again in 1989 approximately 70% of the sample understood that when a factory releases sulfur dioxide, it will return to the earth as acid rain. Approximately 41% of the

were aware that burning fuel causes pollution. However, a majority of the students demonstrated little knowledge concerning the long term consequences of utilizing that type of energy in terms of the greenhouse effect.

The students' pattern of responses in regard to acid rain was similar. Most students understood that when a factory releases sulfur dioxide it will return to earth as acid rain, but a majority of students could not recognize the scientific process of acid rain. Similarly, less than half of the sample could identify the proper solution for a company which is producing large amounts of sulfuric acid waste. These results suggest that most high school seniors possess an extremely elementary comprehension of environmental problems and lack the necessary understanding to go beyond the common recognition of an issue in order to use their knowledge to grasp the consequences of environmental problems or offer solutions for those problems.

Performance on the Environmental Knowledge Scales

Analyses of the items grouped together as environmental knowledge scales present a similar picture. As shown in Table 3, in tenth-grade the mean number of items correct was 3.56 with a standard deviation of 1.60. This finding suggests that the average tenth-grade student answered fewer than four of the seven items correctly. Slightly more than a quarter (28.5%) of the students answered five or more items correctly.

items correctly were classified as having an unsatisfactory level of environmental knowledge. For each criterion variable, a chi-square test of independence was computed to examine the relationship between the criterion variables and the students' level (satisfactory or unsatisfactory) of environmental knowledge.

On the basis of the results presented in Table 4, it is clear that the amount of formal education a student's parent received is significantly related to the student's level of knowledge concerning environmental issues (Chi-square (4) = 54.09, $p < .001$). Approximately 18% of students whose parents did not graduate from high school correctly answered at least five of the seven items. When a student's parent graduated from high school, the proportion of students who displayed a satisfactory level of environmental knowledge increased to just over 32%. Almost half (45.9%) of the students whose parents had earned a four-year college degree demonstrated satisfactory understanding. While parental education appears to be related to a student's level of environmental knowledge, the proportion of students achieving the satisfactory level of environmental knowledge across all levels of parental education remain disappointingly low.

Insert Table 4 about here

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satisfactory level on the scale doubled (44%) for students who took three science classes. Approximately 64% of high school seniors who took four or more science classes attained at least the satisfactory level on the scale. Only about one-third (35.5%) of students who had taken two science classes achieved satisfactory understanding on the environmental knowledge scale. This figure is especially disappointing when coupled with the finding that most students (66.7%) had not taken more than two science classes in high school (See Table 5).

Insert Table 6 about here

As shown in Table 7, male high school students were significantly more likely to have a satisfactory understanding of environmental problems than female high school students (Chi-square (1) = 41.18, $p < .001$). Approximately 44% of the male students answered at least five of seven items on the scale correctly. In contrast, only 29% of the female students achieved at the satisfactory standard. In order to determine if differences in the number science classes taken among males and females could account for differences in environmental knowledge, we computed a cross-tabulation of gender crossed with scores on the environmental knowledge scale while controlling for the number of science classes the students had taken.

square (1) = 17.84, $p < .001$). Approximately three quarters of the males who took four or more science classes attained the satisfactory standard while 52.3% of the females who took four or more science classes obtained at least a satisfactory score (Chi-square (1) = 11.27, $p < .001$). The pattern remains consistent throughout the analysis; a larger proportion of males achieved or exceeded the satisfactory standard compared to females when controlling for the number of science classes taken. In fact, the size of the discrepancy appears to increase as the students take more science classes.

Insert Table 8 about here

DISCUSSION

Levels of Environmental Knowledge

The assessment of the amount of environmental knowledge possessed by American high school students revealed disappointing levels of knowledge. In twelfth-grade, the average student could not correctly answer four of the seven items on the scale, and only approximately one-third (36.3%) of the high school seniors correctly answered five or more of the items.

In an effort to interpret the students' responses to the individual items on the environmental knowledge scales, a taxonomy of the items was devised. The items which made up the

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questions concerning the greenhouse effect were the only items on which the students showed substantial growth (11.3% and 6%). Both of these items were in the knowledge application category and were related to the consequences of the greenhouse effect. While this growth was confined to two items, it is encouraging because it suggests that the students may be beginning to apply their knowledge concerning the greenhouse effect to understand some of the potential long term effects of the problem. The growth displayed on these items could be due, in part, to the increased media coverage of the greenhouse effect.

These combined results indicate that a majority of high school students have low levels of environmental knowledge, and they cannot apply the knowledge that they do have. These current levels of environmental knowledge seem insufficient and will not permit these students to successfully confront environmental issues and make intelligent decisions concerning the environmental hazards which will be faced in the future. These findings are especially alarming because many of these students will not receive any more formal education because they have completed high school.

The Distribution of Environmental Knowledge

Examining the distribution of environmental knowledge across different variables provided some evidence pertaining to the factors which influence environmental knowledge. As expected, students whose parents received more formal education had higher

that the difference between males and females was largely due to differing amounts of science education in high school. However, the results of this study suggest that when male and female students took the same number of science classes, male students possessed more environmental knowledge than female students. Consequently, in the present study, gender emerged as an influential factor in regard to the development of environmental knowledge in high school students.

One possible explanation for this unexpected finding is that the present study did not include a measure of environmental attentiveness. Miller (1990) reported that while males were more likely to understand the problems associated with the hole in the ozone layer than females, the number of science classes taken and attentiveness to environmental issues largely account for most of the difference. Thus, a measure of environmental attentiveness may be an important variable in regard to gender differences concerning environmental knowledge and could assist researchers in clarifying the ultimate reasons behind this finding.

Together, these results indicate that most tenth-grade students have a low level of environmental knowledge; moreover, students demonstrated very little growth in knowledge from tenth-grade to twelfth-grade. The little knowledge that students do possess seems to be basic knowledge as evidenced by the students' inability to correctly answer questions requiring the application of knowledge. Factors which were found to be related to environmental knowledge include the amount of formal education a

is not used spontaneously in problem solving even though it is relevant" (p. 2). Whitehead's (1929) views on inert knowledge have influenced several modern learning theorists who are attempting to develop critical thinking skills in students (e.g., Bransford, J.D., Sherwood, R., Vye, N.J., & Rieser, J., 1986; Brown, J.S., Collins, A., & Duguid, P., 1989). These theorists suggest that teachers should make information meaningful to the students and train students to use their knowledge as an instrument for problem solving. Bransford, Sherwood, & Hasselbring (1988) have shown that when students learn new information in meaningful contexts (under problem solving conditions), students begin to understand the various circumstances for which it is appropriate to apply concepts and facts in order to solve problems. Recent studies (Adams, Kasserman, Yearwood, Perfetto, Bransford, & Franks, 1988; Lockhart, Lamon, & Gick, 1988) have demonstrated that the problem of inert knowledge can be at least partially avoided through the use of specific instructional techniques. The results of these studies suggest that instructional techniques which provide a purposeful, problem-oriented context for learning are more likely than techniques which employ a fact-oriented approach to prevent inert knowledge problems (See The Cognition and Technology Group at Vanderbilt (1990) for a discussion of inert knowledge and specific techniques to prevent it). Thus, in order to help students use environmental knowledge in critical thinking, teachers should supply students with a meaningful, problem-

References

Adams, L., Kasserman, J., Yearwood, A., Perfetto, G., Bransford, J., & Franks, J. (1988). The effects of fact versus problem-oriented acquisition. Memory & Cognition, 16, 167-175.

Albrecht, D., Bultena, G., Hoiberg, E., & Nowak, P. (1982). The new environmental paradigm scale: Measuring environmental concern. Journal of Environmental Education, 13, 39-43.

Arcury, T.A., & Johnson, T.P. (1987). Public environmental knowledge: A statewide survey. Journal of Environmental Education, 18, 31-37.

Arcury, T.A., Johnson, T.P., & Scollay, S.J. (1986). Ecological worldview and environmental knowledge: The "new environmental paradigm". Journal of Environmental Education, 17, 35-40.

Arbuthnot, J. (1977). The roles of attitudinal and personality variables in the prediction of environmental behavior and knowledge. Environment and Behavior, 9, 217-232.

Astin, A. (1990). The American freshman: National norms for fall, 1990. Los Angeles, CA: Higher Education Research Institute.

Barrow, L.H., & Morrisey, J.T. (1988-1989). Energy literacy of ninth-grade students: A comparison between Maine and New Brunswick. Journal of Environmental Education, 20, 22-25.

Berke, R.L. (1990). Oratory of environmentalism becomes the sound of politics. The New York Times, 139, C18-C19.

Blum, A. (1987). Students' knowledge and beliefs concerning environmental issues in four countries. Journal of Environmental Education, 18, 7-13.

Bransford, J.D., Sherwood, R., & Hasselbring, T. (1988). The video revolution and its effects on development: Some initial thoughts. In G. Foreman & P. Pufall (Eds.), Constructivism in the computer age (pp. 173-201). Hillsdale, NJ: Erlbaum.

Bransford, J.D., Sherwood, R., Vye, N.J., & Rieser, J. (1986). Teaching thinking and problem solving: Research foundations. American Psychologist, 41, 1078-1089.

Brody, M., Chipman, E., & Marion, S. (1988-1989). Student knowledge of scientific and natural resource concepts concerning acidic deposition. Journal of Environmental Education, 20, 32-42.

Jones, L.V. (1988-1989). School achievement trends in mathematics and science, and what can be done tc improve them. In E. Z. Rothkopf (Ed.), Review of research in education (Vol. 15, pp. 307-341). Washington, DC: American Educational Research Association.

Lockhart, R.S., Lamon, M., & Gick, M.L. (1988). Conceptual transfer in simple insight problems. Memory & Cognition, 16, 36-44.

Milbrath, L.W. (1990). Environmental understanding: A new concern for political socialization. In O. Ichilov (Ed.), Political socialization, citizenship education, and democracy (pp. 281-293). New York, NY: Teachers College Press, Columbia University.

Miller, J.D. (1983). The American people and science policy. New York: Pergamon Press, Inc.

Miller, J.D. (1990). The public understanding of science & technology in the United States, 1990. (A report submitted to the National Science Foundation). DeKalb, IL: Public Opinion Laboratory.

Miller, J.D., Suchner, R.W., Hoffer, T., Brown, K.G., & Pifer, L. (1991). LSAY codebook: Student, parent, and teacher data for cohort one for longitudinal years one, two, and three (1987-1990). Northern Illinois University, Public Opinion Laboratory, DeKalb, IL.

National Wildlife Federation (1990). Planet in peril: A view from the campus. (A report submitted to the National Wildlife Federation). Washington, D.C.: National Wildlife Federation.

National Assessment of Educational Progress (1988). The science report card: Elements of risk and recovery. (Report No. 17-S-01). Princeton, NJ: Educational Testing Service.

Whitehead, A.N. (1929). The aims of education. New York: MacMillan.

Table 1 (Continued)

(5) What happens to the sulfur dioxide released by a factory's smokestacks?

(A) The sulfur dioxide stays in the air forever.
(B) The sulfur dioxide immediately falls to earth as dust.
(C) The sulfur dioxide eventually falls to the earth as acid rain. *
(D) The sulfur dioxide escapes from the atmosphere into space.

(6) The ores of many metals are sulfides of the metals. In the refining process these ores are "roasted," that is, the sulfur is combined with oxygen, liberating the metal or its oxide (e.g., $CuS + O2 \rightarrow Cu + SO2$). This process is most likely to result in which of the following?

(A) Acid rain *
(B) Aging of lakes
(C) Depletion of the ozone layer
(D) Lead poisoning

(7) A paper manufacturing company in your area produces large amounts of sulfuric acid as a waste by-product. In spite of efforts to carefully dispose of the waste, some acid continually escapes recovery and pollutes a nearby river, affecting wildlife and recreation. The company employs many area residents. Which of the following solutions to help stop the pollution would be preferred by the community?

(A) Moving the company to a more isolated area and giving the worker the option to move
(B) Adding a substance to the escaping acid to neutralize it *
(C) Adding an acid with a higher pH to the escaping acid
(D) Storing the escaping acid in large holding tanks and then taking it to an industrial waste landfill

Table 3: 10th-Grade and 12th-Grade Environmental Knowledge Frequency Table

VALUE	10th-Grade PERCENT	12th-Grade PERCENT
.00	1.9	2.0
1.00	8.5	8.4
2.00	15.7	14.8
3.00	23.2	18.3
4.00	22.3	20.3
5.00	16.3	17.5
6.00	8.6	12.4
7.00	3.6	6.4
TOTAL	100.0	100.0

Tenth-Grade MEAN = 3.56 STANDARD DEVIATION = 1.60
Twelfth-Grade MEAN = 3.80 STANDARD DEVIATION = 1.74
N = 1870

Table 5: Number of Science Classes Taken in High School

VALUE	FREQUENCY	PERCENT	CUM PERCENT
0 CLASSES	257	11.6	11.6
1 CLASS	573	26.0	37.6
2 CLASSES	642	29.1	66.7
3 CLASSES	477	21.6	88.3
4 - 6 CLASSES	259	11.7	100.0
TOTAL	2208	100.0	100.0

MEAN = 1.96 STANDARD DEVIATION = 1.19

Table 7: Percentage of Twelfth-Graders Who Displayed Satisfactory (five of seven items correct) Environmental Knowledge by Gender

Gender	Percent Satisfactory
Female	29.2% (951)
Male	43.6% (917)

( ) = N
* Chi-square (1) = 41.18, $p < .001$.
Total N = 1868